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[Abstract]

PURPOSE: To automatically determine a drawing order at the time of drawing plural patters on the same substrate only by inputting the positional data on the patterns.

CONSTITUTION: The positional data on the patterns pp1 to pp6 to be drawn on a substrate 7 are inputted, and a pattern to be initially drawn is determined from the substrate 7 introducing direction to the paste applicator based on the positional data. If the substrate 7 is introduced from the right-hand side, the pattern pp1 is used, and the substrate is coated with the pattern pp1 from the starting point s1. When the substrate reaches an end point e1, a pattern having a starting point (end) closest to the end point e1 is

retrieved among the patterns pp2 to pp6. and, if the pattern pp2 is selected, the pattern pp2 is drawn from the starting point s2, and the order to draw the patterns pp3 to pp6 are determined in the same way.

[Claims]

[Claim 1]

A paste applicator characterized in that a substrate is positioned on a table so as to face a discharge port of a nozzle, a relative position relation between the nozzle and the substrate is varied by discharging a paste charged in a paste syringe from the discharge port onto the substrate, and a paste pattern of a desired shape is formed on the substrate, the paste applicator comprising:

a first means for inputting position data of a paste pattern;

a second means for storing the position data of a plurality of paste patterns inputted from the first means;

a third means for determining a drawing sequence of each paste pattern from the position data stored in the second means; and

a fourth means for drawing the plurality of paste patterns according to the sequence determined by the third means.

2. The paste applicator of claim 1, wherein the third means determines a paste pattern having an edge located at the nearest position from a position directly below the nozzle when the substrate is being carried in as a first paste pattern.

3. The paste applicator of claim 1, wherein the third means determines a paste pattern having an edge located at the nearest position from a drawing ending portion of a paste pattern of which the drawing sequence has been determined as a paste pattern to be subsequently drawn.

4. The paste applicator of claim 1, wherein if there are a plurality of paste patterns respectively having an edge located at the nearest position from a drawing ending point of the paste pattern of which the drawing sequence has been determined, the third means determines a paste pattern having an edge located at the nearest position from an X axis direction or a Y axis direction as a paste pattern to be subsequently drawn.

5. The paste applicator of claim 1, wherein the third means is provided with a means for excluding a paste pattern of which a drawing sequence has been determined from paste patterns to be drawn.

6. The paste applicator of claim 1, wherein the third means arbitrarily divides all paste patterns to be drawn on the substrate according to a position relation, and determines a paste pattern having an edge located at the nearest position from a drawing ending point of a paste pattern of which drawing sequence has been determined as a paste pattern to be subsequently drawn.

7. The paste applicator of claim 6, wherein when a drawing of a final paste pattern of a group is completed, the third means determines a paste pattern having an edge located at the nearest position from a drawing ending point of the final paste pattern and included in a group except the group to which the final paste pattern belongs as a paste pattern to be drawn first.

[Title of the Invention]

PASTE APPLICATOR

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to a paste applicator capable of drawing a paste pattern of a desired shape on a substrate by discharging a paste from a nozzle onto a substrate positioned on a table and thereby relatively moving the substrate and the nozzle, and more particularly, to a paste applicator capable of drawing a plurality of paste patterns on the same substrate in a predetermined order.

[Description of the Prior Art]

In the Japanese patent No.2-52742, disclosed is a paste applicator using a discharge drawing technique for drawing a paste on a substrate as a desired pattern by fixing a nozzle to a distal end of a paste syringe in which a paste is contained, by facing the nozzle to a substrate positioned on a table, by horizontally moving at least one of the nozzle and the substrate while the paste is discharged from a discharge port of the nozzle, and thereby varying a position relation between the substrate and the nozzle. The paste applicator is for drawing a resistive paste on an insulating substrate as a desired pattern.

[Problems to be Solved by the Invention]

In case of drawing a plurality of paste patterns on the same substrate by a paste applicator in accordance with the prior art, an operator had to input

data such as a position, a length, a drawing sequence of each paste pattern to be drawn on the substrate. Especially, in case of inputting the drawing sequence, even a skilled operator for the drawing sequence had to re-input data or re-examine the data and it took a lot of time.

A paste applicator can not be used while data is inputted. Whenever a substrate is changed, the operator had to input data required for a drawing, so called a tooling change. The more the tooling change is increased, the less a utilization rate of the paste applicator is.

An object of the present invention is to provide a paste applicator capable of automatically determining a drawing sequence of each paste pattern merely by inputting position data of the plural paste patterns, capable of shortening the preparatory work for drawing a pattern, and capable of enhancing the productivity.

[Means for Solving the Problem]

In order to attain the above-mentioned object, the present invention is provided with a first means for inputting position data of a paste pattern, a second means for storing the position data of a plurality of paste patterns inputted from the first means, a third means for determining a drawing sequence of each paste pattern from the position data stored in the second means, and a fourth means for drawing the plurality of paste patterns according to the sequence determined by the third means.

The third means determines a paste pattern having an edge in the nearest position from a position directly below the nozzle when a substrate is being carried in as a first paste pattern.

Furthermore, the third means determines a paste pattern having an edge in the nearest position from a drawing ending point of a paste pattern of which drawing sequence has been completed as a paste pattern to be drawn next.

The third means connects endpoints, such as each starting point and each ending point of a plurality of paste patterns in the shortest path. Even if each paste pattern is drawn in an arbitrary sequence, a drawing distance of each paste pattern itself does not change. Even if a straight-line path between connected endpoints of each paste pattern is not the shortest, there is a drawing sequence that the total between the drawing distance of each paste pattern and the connection between the endpoints of each paste pattern in the straight-line path is shorter than the shortest straight-line path between the endpoints of each paste pattern.

However, in order to determine the drawing sequence, the total extension distances have to be calculated by combining the connected lengths between the endpoints of each paste pattern. Then, the shortest extension distance has to be selected among the total extension distances. The more the number of paste patterns drawn on a substrate is increased, the more the number of combinations is increased and it takes a lot of time. Accordingly, it is difficult to determine a drawing sequence.

In the present invention, the third means connects the endpoints of each paste pattern in the shortest straight-line path so that a drawing sequence may be determined simply and a drawing operation may be promptly performed even if the total extension distance is long to some degree. Since the number of the shortest straight-line paths is decreased as the number of paste patterns of which drawing sequence have been

determined is increased, the drawing sequence is simply determined in a short time.

[Embodiment of the Invention]

Hereinafter, preferred embodiments of the present invention will be explained.

FIGURE 1 is a perspective view showing one embodiment of a paste applicator according to the present invention. As shown in FIGURE 1, 1 denotes a nozzle, 2 denotes a syringe, 3 denotes an optical displacement meter, 4 denotes a Z axis table, 5 denotes an X axis table, 6 denotes a Y axis table, 7 denotes a substrate, 8 denotes a Θ axis table, 9 denotes a mounting unit, 10 denotes a Z axis table supporter, 11a denotes an image recognition camera, 11b denotes a lens barrel, 12 denotes a nozzle supporting unit, 13 denotes a sucking base, 14 denotes a controller, 15a to 15c denote servo motors, 16 denotes a monitor, 17 denotes a key board, and 19 denotes an external storage.

Referring to FIGURE 1, the X axis table 5 is fixed on the mounting unit 9, and the Y axis table 6 is mounted on the X axis table 5 to be movable in the X axis direction. The Θ axis table 8 is rotatably mounted on the Y axis table 6 to be movable in the Y axis direction, and the sucking base 13 is fixed on the Θ axis table 8. The substrate 7 is fixed on the sucking base 13 so that each edge thereof may be parallel with the X axis and the Y axis.

The substrate 7 carried on the sucking base 13 can be moved in the X axis direction and the Y axis direction by the controller 14. That is, the servo motor 15b is driven by the controller 14, the Y axis table 6 is moved in

the X axis direction and thereby the substrate 7 is moved in the X axis direction. Also, if the servo motor 15c is driven, the Θ axis table 8 is moved in the Y axis direction and thereby the substrate 7 is moved in the Y axis direction. Accordingly, as the Y axis table 6 and the Θ axis table 8 are respectively moved as much as an arbitrary distance, the substrate 7 is moved in an arbitrary direction in a surface parallel with the mounting unit 9 as much as an arbitrary distance.

The Θ axis table 8 can be rotated as much as an arbitrary amount in the Θ direction by the servo motor 15d shown in FIGURE 3 centering around the center thereof.

The Z axis table supporter 10 is installed on the mounting unit 9, and the Z axis table 4 is installed on the Z axis table supporter so as to movable in the Z axis direction (up and down directions). On the Z axis table 4, the nozzle 1, the syringe 2, and the optical displacement meter 3 are mounted. The Z axis table 4 is controlled in the Z axis direction by the controller 14. That is, if the servo motor 15a is driven by the controller 14, the Z axis table 4 is moved in the Z axis direction and thereby the nozzle 1, the syringe 2, and the optical displacement meter 3 are moved in the Z axis direction.

The image recognition camera 11a is installed at the left side of the Z table 4 on the Z axis table supporter 10. However, since the image recognition camera 11a is movable, it may be installed at the right side of the Z axis table supporter 10. Also, a beam member (not shown) may be installed back and forth along right and left sides of the mounting unit 9. An installed position of the image recognition camera 11a can be properly moved according to a carried-in direction of the substrate 7 by installing the

image recognition camera 11a to the beam member.

FIGURE 2 is an enlargement perspective view showing the syringe 2 and the optical displacement meter 3 of FIGURE 1, in which the same reference numerals were given to the same parts as those of FIGURE 1.

Referring to FIGURE 2, a cut portion of a triangle shape is formed at a lower end of the optical displacement meter 3, and a light emitting device and a light receiving device are installed at the cut portion. A nozzle supporting unit 12 extended to a lower portion of the cut portion of the optical displacement meter 3 is installed at a lower end of the syringe 2. Also, a nozzle 1 is installed at a lower surface of the nozzle supporting unit 12 so as to be positioned at a lower side of the cut portion of the optical displacement meter 3.

The optical displacement meter 3 measures a distance between an end of the nozzle and a surface of the substrate 7 by a non-contact triangulation. That is, laser L emitted from the light emitting device of the optical displacement meter 3 is irradiated onto a lower side of the nozzle 1 on the substrate 7 (the irradiated point is called as a measuring point S), and is reflected into the measuring point S thereby to be received into the light receiving device of the optical displacement meter 3. If a distance between the end of the nozzle 1 (paste discharge port) and the substrate 7 is changed, the position of the measuring point S, the position directly below the nozzle 1 is changed and thereby a received state of the reflected light into the light receiving device is changed. Accordingly, by detecting the change, the distance between the end of the nozzle 1 and the surface of the substrate 7, that is, the height of the nozzle 1 can be measured.

The light emitting device and the light receiving device are installed at different sides of the cut portion of the optical displacement meter 3 so as not to shield the laser L by the nozzle supporting unit 12, and the laser L is emitted in a gradient direction to be reflected in a gradient direction.

The measuring point S by the laser L is a little misaligned from the position directly below the nozzle 1 on the substrate 7 only in dX and dY. However, the little difference between the measuring point S on the surface of the substrate 7 and the position directly below the nozzle on the substrate does not greatly influence on a concave-convex structure of the surface of the substrate 7. Accordingly, the distance between the distal end of the nozzle 1 and the surface of the substrate 7 directly below the nozzle can be nearly precisely measured by the optical displacement meter 3.

FIGURE 3 is a block diagram showing the controller 14 and a system to be controlled by the controller of FIGURE 1. Referring to FIGURE 3, 14a denotes a micro computer, 14b denotes a motor controller, 14e denotes an external interface, 14d denotes an image processor, 14ca denotes a Z axis driver, 14cb denotes an X axis driver, 14cc denotes a Y axis driver, 14cd denotes a Θ axis driver, 15d denotes a Θ axis motor, 18 denotes an A-D converter, E denotes an encoder, and PP denotes a paste pattern. The same reference numerals were given to the same parts as those of FIGURE 1.

Referring to FIGURE 3, the micro computer 14a is provided with a ROM for storing soft processing programs to operate a CPU, a drawing of a paste pattern, a RAM for storing result data of the CPU and input data from the external interface 14e and the motor controller 14b, and an input/output unit for exchanging data with the external interface 14e and the motor

controller 14b. The RAM also stores each data for a paste pattern to be explained later (a set nozzle height or a threshold value, etc.) inputted from a keyboard 17 at the time of an initial setting.

A data inputting device such as the key board 17 inputs data for a desired shape of a paste pattern to be drawn, and data for a desired distance between the nozzle 1 and the substrate 7 which determines a thickness of a thickness of a paste pattern (a nozzle height or a minimum physical amount for reaction). The inputted data is supplied to the micro computer 14a via the external interface 14e. The micro computer 14a processes the data by using the CPU or the RAM according to the soft programs stored in the ROM.

The motor controller 14b is controlled according to the data for determining a desired shape of a paste pattern. Also, the X axis motor 15b, the Y axis motor 15c, or the Θ axis motor 15d are rotated by the X axis driver 14cb, the Y axis driver 14cc, or the Θ axis driver 14cd. The encoder E is installed at rotation shafts of the motors thereby to detect a rotation amount of each motor. The detected rotation amount is fed back to the micro computer 14a through the X axis driver 14cb, the Y axis driver 14cc, or the Θ axis motor 15d, or the motor controller 14b. The X axis motor 15b, the Y axis motor 15c, or the Θ axis motor 15d are controlled to be precisely rotated as much as a preset rotation amount by the micro computer 14a. Accordingly, the preset paste pattern is drawn on the substrate 7. While a paste pattern is being drawn, data measured by the optical displacement meter 3 is converted into digital data by the A-D converter 18, and is supplied to the micro computer 14a through the external interface 14e. Then, the data is compared with a minimum physical amount stored in the RAM for the

reaction.

If there is a concave-convex on the surface of the substrate 7, the micro computer 14a detects the concave-convex by the above comparison, controls the motor controller 14b by the comparison result, and rotates the Z axis motor 18 by the Z axis driver 11cd. Accordingly, the micro computer 14a displaces the Z axis table 4 (FIGURE 1) up and down thereby to maintain a height of the discharge port of the nozzle 1 (FIGURE 2) from the surface of the substrate 7 as a set nozzle height. The encoder E is also installed at a rotation shaft of the Z axis motor 18 thereby to feed back a rotation amount of the Z axis motor 18 to the micro computer 14a through the Z axis driver 11cd or the motor controller 14b. Accordingly, the Z axis motor 18 is controlled to be precisely rotated as much as a preset rotation amount by the micro computer 14a.

During the above process, an air pressure is applied to the syringe 2 to discharge a paste from the nozzle 1, thereby drawing a paste pattern of a desired width and a desired height on the substrate 7.

An operation for drawing a paste pattern shown in FIGURE 1 and an operation for determining a drawing sequence by a drawing sequence determining unit mounted in the micro computer 14c shown in FIGURE 3 will be explained.

There are four types for carrying in a substrate from a paste applicator as shown in FIGURES 4A to 4D. First, the substrate is carried in from the left side of the paste applicator on the basis of an operator (OP) (FIGURE 4A). Second, the substrate is carried in from the right side of the paste applicator on the basis of the operator (OP) (FIGURE 4B). Third, the

substrate is carried in from the front side of the paste applicator on the basis of the operator (OP) (FIGURE 4C). And, fourth, the substrate is carried in from the rear side of the paste applicator on the basis of the operator (OP) (FIGURE 4D).

The sucking base 13 on which the substrate 7 is positioned is moved to a carried-in side of the substrate 7 in order to easily carry-in the substrate as shown in FIGURES 4A to 4D. The nozzle 1 is fixed not to be moved in the X axis direction and in the Y axis directions, that is, in right and left directions and in back and forth directions, but the substrate 7 is moved. Accordingly, a lateral end of the substrate nearest to the nozzle 1 is different according to the carried in direction of the substrate 7.

The paste applicator is installed during a manufacturing line, and the substrate 7 is carried according to a production flow of the manufacturing line. Accordingly, the carried-in direction of the substrate 7 is not changed in the manufacturing line. Also, if the image recognition camera 11a is installed at the beam member (not shown) or the Z axis table supporter 10, the installation position thereof will not be changed as long as the manufacturing line is not changed.

As shown in FIGURE 5, 6 paste patterns (pp1 to pp6) are drawn on the same substrate 7. A drawing sequence determining unit mounted in the micro computer 14a selects a paste pattern pp nearest to the nozzle 1 under a state that the substrate 7 has been carried in, that is, the substrate 7 is positioned on the sucking base 13 as a first paste pattern pp to be drawn. For example, if the substrate is carried in from the right side of the paste applicator on the basis of an operator as shown in FIGURE 4B, the paste

pattern pp1 in FIGURE 5 is determined as a paste pattern to be drawn first.

Starting points s1 to s6 and ending points e1 to e6 of the paste patterns pp1 to pp6 are predetermined. If the drawing of the paste pattern pp1 is completed, the paste pattern pp2 having a starting point s2 nearest to the ending point e1 of the paste pattern pp1 is selected as a paste pattern to be drawn next. Then, the above process is repeated thereby to vary the relative position relation between the nozzle 1 and the substrate 7 in order to perform a drawing in paths shown as the solid line and the dotted line of FIGURE 5.

Referring to FIGURE 5, the solid line arrow denotes a drawing path of a paste pattern, and the dotted line arrow denotes a motion path of a paste pattern. The drawing operation is performed in the order of pp1, pp2, pp3, pp6, pp5, and pp4. The drawing sequence determination will be explained in more detail.

As shown in FIGURE 6, the micro computer 14a completes a drawing sequence data file DF2 based on a patterning data file DF1 of the RAM, and draws each paste pattern pp1 to pp6 based on the data files DF1 and DF2.

An operation of the paste applicator will be explained in more detail with reference to a soft chart showing programs stored in the ROM inside the micro computer 14a.

Referring to FIGURE 7, a power is applied to the paste applicator (FIGURE 1, R>1) (S100), an initialization of the paste applicator is set (S 200).

As shown in FIGURE 8, the initialization is performed by certifying the original position of each table (4 to 8) (S201), by setting data for drawing

a paste film or data for a substrate position determination (S202), and by setting data for a paste discharge completion position (S203).

When the initialization setting is completed, a drawing sequence determining process (S300) is performed. The drawing sequence determining process will be explained with reference to FIGURE 9.

First, data for each starting point is read by the pattern data for a paste film set in the step 202 of FIGURE 8 (S301). Then, a paste pattern to be drawn first, that is, a first drawing pattern is determined, and data for a drawing starting point of the pattern is stored in the first row of the drawing sequence data file DF2 shown in FIGURE 6 (S302). The paste pattern pp1 in FIGURE 5 is determined as the first drawing pattern.

Even if a paste pattern of which sequence has been determined is not shown, a process for releasing objects to be sequence-determined is performed by setting a flag at each paste pattern of the patterning data file DF1 of FIGURE 6. Accordingly, a paste pattern of which drawing sequence has been determined does not become an object to be sequence-determined again. As the sequence determination is performed, the number of paste patterns to be sequence-determined is decreased thereby to perform the sequence determination in a short time.

A process for determining a first drawing pattern will be explained in more detail with reference to FIGURE 10.

An ending point of a pattern that has been drawn is calculated in order to determine a paste pattern to be drawn next (S303). That is, an ending point of the first drawing pattern is obtained in order to determine the second drawing pattern.

The term of 'calculated' is derived with consideration of a method for setting each paste pattern. If a paste pattern is set according to data for a drawing position of each paste pattern, abundant data has to be stored in the RAM of the micro computer 14a and a RAM of a large capacity is necessary. For example, if a paste pattern is set by sequentially setting a progressive direction or a changed position of each paste pattern of FIGURE 5, the amount of data stored in the RAM can be greatly reduced. In this case, position data is not immediately searched but is obtained by a calculation.

Then, a starting point of a drawing pattern nearest to an ending point of a paste pattern that has been drawn in S303 is searched among starting points of the rest drawing patterns read in S301 (S304).

A paste pattern of which starting point has been searched is the second drawing pattern, and is stored in the second sequence of the drawing sequence data file DF2 of FIGURE 6 (S305). In FIGURE 6, the paste pattern pp2 of FIGURE 5 is determined as the second drawing pattern. The process for determining a drawing sequence (S304) will be explained in more detail with reference to FIGURE 11.

Then, whether a drawing sequence for every pattern pp1 to pp6 has been determined or not is checked (S306). If the drawing sequence has not been completed, the process is returned to the step 303 to continuously perform the above determination process. On the contrary, if the drawing sequence for every pattern pp1 to pp6 has been determined, the drawing sequence determining process (S300) is finished.

A process for determining a first drawing pattern and a process for sequentially storing the drawing pattern of FIGURE 9 (S302) will be

explained with reference to FIGURE 10.

As shown in FIGURE 4, data for showing a carried in direction of the substrate 7 is inputted (S302-1). Then, it is judged whether the substrate 7 is carried in from the left side on the basis of the input data (S302-2). If the substrate 7 is carried in from the left side, a drawing pattern having a starting point nearest to the nozzle 1 among paste patterns drawn on a first quadrant or a fourth quadrant in a condition that a center of the substrate 7 is an origin is determined as a first drawing pattern (S302-3).

Then, whether the step for determining the first drawing pattern has been completed is judged (S302-4). If the step has been completed, the process undergoes the step 302-6. However, if the step has not been completed, a paste pattern nearest to the nozzle 1 is selected among paste patterns drawn on a second quadrant or a third quadrant (S302-5).

If the substrate 7 is carried in from the left side, the first drawing pattern is precisely selected by the steps 302-3 and 302-5.

If the substrate 7 is not carried in from the left side, it is judged whether the substrate 7 is carried in from the right side (S302-6). If the substrate is carried in from the right side, the above processes are performed by the steps 302-7 to 302-9 and the first drawing pattern is selected.

If the substrate 7 is not carried in from the right side, it is judged whether the substrate 7 is carried in from the back side (S302-10). If the substrate is carried in from the back side, a first drawing pattern is selected by the steps 302-11 to 302-13. However, if the substrate is carried in from the front side, a first drawing pattern is selected by the steps 302-14 to 302-17.

When the first drawing pattern is selected by one of the steps 302-2, 302-6, 302-10, and 302-14, the first drawing pattern is stored in the drawing sequence data file DF2 of FIGURE 6 (Step 302-18). In FIGURE 6, the paste pattern pp1 is selected as a paste pattern nearest to the nozzle 1, so that the substrate 7 is carried in from the right side.

Hereinafter, a process for searching a starting point of a drawing pattern nearest to an ending point of FIGURE 9 (S304) will be explained with reference to FIGURE 11.

First, starting point data for drawing patterns of which drawing sequence have not been determined is read (S304-1). In FIGURE 6 (R>6), a second drawing pattern is determined among paste patterns pp2 to pp6 of which drawing sequence have not been determined.

Then, a straight-line distance between the ending point e1 of the paste pattern pp1 selected as the first drawing pattern and the second drawing pattern is calculated by using position data of each starting point s2 to s6 of the non-determined patterns pp2 to pp6 (S304-2). The distance is calculated in order to select a second drawing pattern in a straight-line so that the nozzle 1 can be moved to the next starting point after stopping a paste discharge.

In FIGURE 11, the ΔX and ΔY respectively denote a misalignment between the ending point e1 of the paste pattern pp1 and the starting points s2 to s6 of each non-determined pattern pp2 to pp6 on the X axis and the Y axis.

Among the paste patterns having a moving distance S between each pattern, a pattern having a minimum distance is selected (S304-3). Since a

plurality of non-determined patterns having a minimum distance may exist, it is judged that the number of non-determined patterns having a minimum distance is 1 (S304-4). At this time, if the number of non-determined patterns having a minimum distance is more than two, a non-determined pattern having a starting point of which distance towards the X axis direction is the shortest is selected (S304-5).

Then, it is judged whether the selection is to be effective or not (S304-6). If a drawing pattern to be drawn in the X axis direction does not exist, a non-determined pattern having a starting point of which distance towards the Y axis direction is the shortest is selected and the selected pattern is processed as a second drawing pattern (S304-7).

In order to determine a third drawing pattern, the same process as FIGURE 11 is performed on the basis of the selected second drawing pattern. In FIGURE 5, the drawing sequence data file DF2 is constructed as a form shown in FIGURE 6.

In FIGURE 11, the step 304-5 and the step 304-7 may be exchanged to each other. In case of FIGURE 11, a drawing pattern is preferably shifted in a horizontal direction. However, in case that the step S304-5 and the step 304-7 are exchanged to each other, a drawing pattern is preferably shifted in a vertical direction.

As aforementioned, in the preferred embodiment, even an inexpert operator can perform a drawing operation merely by inputting data such as a position and a length of each paste pattern to be drawn on the substrate 7. Accordingly, a drawing sequence of the paste pattern is automatically determined, re-examination and re-input of data are not required, a drawing

operation is immediately performed, a tooling change is facilitated, and a utilization rate of the paste applicator is greatly enhanced.

If the substrate 7 is carried in from four sides of the paste applicator, a carried in direction of the substrate is first set. Then, a drawing sequence for the rest paste patterns is automatically determined, and thereby even an inexpert operator can start a drawing operation.

If the process for determining a drawing sequence of the paste applicator of FIGURE 7 (S300) is completed, the next process for mounting the substrate (S400) is performed. In the step S400, the substrate 7 is positioned on the sucking base 13 (FIGURE 1, R>1) and then the position of the substrate 7 is determined (S500).

A process for determining a preliminary position of the substrate 7 will be explained with reference to FIGURE 12.

An aligning mark installed at the substrate 7 and positioned within a viewing angle of a camera is photographed by the image recognition camera 11a (FIGURE 1) (S501). Then, a center position of the aligning mark within the viewing angle of the camera is measured (S502).

The center position is measured by an image recognizing technique and the explanation will be omitted.

Then, a mis-aligned amount between the center of the camera viewing angle and the center of the aligning mark is calculated (S503), and a moved amount of each table 6 and 8 of FIGURE 1 is calculated based on the misaligned amount (S504). Then, the moved amount is set to the motor controller 14b of FIGURE 3 (S505), and each table 6 and 8 is moved (S506).

As the tables 6 and 8 are moved, the center of the camera viewing

angle and the center of the aligning mark are consistent with each other. However, for a probable case, the center position of the aligning mark within the viewing angle of the camera is re-measured (S507), the mis-aligned amount between the center of the viewing angle of the camera and the center of the aligning mark is calculated (S508), whether the mis-aligned amount is within an allowable range of a position determination or not is certified (S509), if the mis-aligned amount is not within an allowable range, the process is returned to the step S504 thereby to repeat the above steps, and if the mis-aligned amount is within an allowable range, the step S500 for determining a substrate position is finished thereby to undergo a process for forming a paste film in FIGURE 7 (S600).

Hereinafter, the process for forming a paste film (S600) will be explained with reference tot FIGURE 13.

First, the substrate 7 is moved to a drawing starting position (S601). Even if the paste pattern pp1 of FIGURE 5 is the first drawing pattern, the starting point s1 of the paste pattern pp1 is not directly below the nozzle 1 in the step that the position of the substrate 7 has been determined. Accordingly, the starting point s1 of the paste pattern is positioned directly below the nozzle 1. Since the substrate 7 is a little moved from the carried in position, it is okay that the substrate 7 is moved to a drawing starting position from the carried in position. The substrate 7 is moved in the shortest time thereby to increase the number of processed substrates (through put).

Then, a height of the nozzle is set (S602), and a paste discharge from the nozzle 1 and a drawing operation are performed (S603). The paste discharge

is performed by pressurizing a paste of the syringe 2 by a discharge pressure by a means (not shown) in FIGURE 1. The drawing operation is performed by relatively moving the nozzle 1 and the substrate 7 by the tables 6 and 8 in correspondence with the shape of the paste pattern pp1 of FIGURE 5.

As the paste discharge and the drawing operation are simultaneously performed, the paste pattern pp1 is drawn on the substrate 7. While the drawing operation is being performed, a concave-convex on the surface of the substrate is measured by the distance between the nozzle 1 and the surface of the substrate by the optical displacement meter 3 (S604). If the distance is less than a constant value (a set height of the nozzle – a height of the paste pattern), the optical displacement meter 3 measures the distance on a paste pattern of which patterning has been completed (S605). At this time, the height of the nozzle is maintained as the initial height at the time of the measurement and a step S608 is performed.

A case that the measure distance is not less than a constant value means that the distance is not measured on the paste film. Accordingly, Z axis compensation data is calculated according to the concave-convex of the substrate 7 (S606), and the Z axis table 8 is controlled thereby to compensate the height of the nozzle into the set height (S607). Then, whether the paste discharge has been completed, that is, whether the nozzle 1 has reached the ending point e1 of the paste pattern pp1 is judged (S608). If the paste discharge has been completed, the process for finishing the paste discharge is performed (S609). However, if the paste discharge has not been completed, the process returns to the step S604 thereby to repeat the

above processes.

After the completion of the paste discharge, the nozzle 1 is lifted (S610) and thereby a drawing of one paste pattern pp1 is completed. Then, whether a patterning for the rest paste patterns has been completed is certified (S611). If the rest paste patterns are not drawn yet, the process returns to the step S601 thereby to draw the rest paste patterns PP.

Data for a starting point of a paste pattern to be drawn next is automatically provided based on the drawing sequence data file DF2 of FIGURE 6. On the basis of the data, the process subsequent to the step S601 is automatically performed without the operator's effort.

If a drawing of all the paste patterns pp to be drawn on one substrate 7 is completed, the substrate 7 is carried out from the paste applicator (S700). Then, whether a drawing operation on all the substrates has been completed or not is certified (S800). If the substrate is being carried in, the process returns to the step S400 thereby to perform a drawing operation on a new substrate. If there is no substrate being carried in, the paste applicator is stopped thereby to finish all the operations.

Even if one embodiment of the present invention was explained, the present invention can have the following another embodiment.

As shown in FIGURE 14, in the step S300 for determining a drawing sequence, the step S302 and the step S303 may be exchanged to each other. According to a paste applicator in which the image recognition camera 11a is fixed to the Z axis supporter 10 or a beam member thereby not to be moved, a paste pattern nearest to the nozzle under a state that the substrate has been carried in is not the first paste pattern but a paste pattern nearest

to the nozzle in the process for determining a substrate preliminary position (S500) is the first pattern in order to minimize a moved amount of the substrate.

In case that the substrate is large and the number of patterns to be drawn is great, an addressing is performed on the substrate and each drawing sequence for a plurality of paste patterns to be drawn in each address is determined. Also, a first drawn pattern and a last drawn pattern in adjacent paste patterns are sequence-aligned thereby to determine a drawing sequence for each paste pattern.

A drawing sequence is sequentially determined from a paste pattern farthest from a carried out position of the substrate, and a paste pattern nearest to the nozzle 1 or the image recognition camera 11a is calculated and then is drawn.

Regardless of the starting edge or the ending edge of each paste pattern, edges of each paste pattern shortest to each other are sequence-determined.

In the step S300 of FIGURE 9, the shape of each pattern is set as a relative coordinate on the substrate in order to reduce the amount of data to be stored in the RAM, and thereby the ending point is calculated in the step S303. In case that the number of patterns to be drawn is less, pattern data is inputted as an absolute coordinate on the substrate. Accordingly, the ending edge position can be searched in the step S303 and the drawing sequence is determined in a short time.

While a paste pattern is being drawn, data for patterns to be drawn next on an additional substrate is inputted by the external storage, that is,

the step S202 in FIGURE 8 is performed. At the time of a tooling change, pre-inputted data is read by the external storage 19, and an operation is fast started. Also, a paste drawing is stopped, the data being executed in the RAM is shifted to the external storage 19 and the next operation is fast started.

At the time of determining a drawing sequence, a carried in direction of the substrate is not inputted, and the first drawing pattern is manually inputted by the key board 17 based on the experience of a skilled operator. The subsequent drawing sequence is automatically determined according to the present invention.

[Effect of the Invention]

As aforementioned, in the present invention, a drawing pattern of each paste pattern is automatically determined and a preparatory operation for drawing a pattern is greatly simplified only by inputting position data of a plurality of paste patterns, thereby greatly enhancing the productivity.

[Description of Drawings]

FIGURE 1 is a perspective view schematically showing one embodiment of a paste applicator according to the present invention;

FIGURE 2 is a perspective view showing an arrangement relation between a syringe and an optical displacement meter of FIGURE 1;

FIGURE 3 is a construction view showing one example of a controller of FIGURE 1;

FIGURE 4 is a view showing a carried in direction of a substrate

towards a paste applicator and a nozzle position when the substrate is carried in;

FIGURE 5 is a view showing one example of a paste pattern drawn on a substrate according to a preferred embodiment of FIGURE 1;

FIGURE 6 is a view showing a construction of a data file inside a RAM of a micro computer of FIGURE 3;

FIGURE 7 is a flowchart showing an operation of FIGURE 1;

FIGURE 8 is a flowchart showing a process for initialization of a paste applicator in FIGURE 7;

FIGURE 9 is a flowchart showing a process for determining a drawing sequence in FIGURE 7;

FIGURE 10 is a flowchart showing a process for determining a first drawing pattern and a process for storing a drawing sequence in FIGURE 9;

FIGURE 11 is a flowchart showing a process for searching a starting point of a drawing pattern nearest to an ending point in FIGURE 9;

FIGURE 12 is a flowchart showing a process for determining a preliminary position of a substrate in FIGURE 7;

FIGURE 13 is a flowchart showing a process for forming a paste film in FIGURE 7; and

FIGURE 14 is a flowchart showing another embodiment of the process for determining a drawing sequence in FIGURE 7.